



## Mid-term Results of Rotating Hinged Knee Prosthesis

### Rotasyonel Menteşeli Diz Protezi Orta Dönem Sunuçları

Rotating Hinged Knee Prosthesis

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#### Özet

**Amaç:** İleri derece de bağ instabilitesi ya da ciddi kemik defekti diz artroplastisi cerrahisinde karşılaşılabilecek zorluklardır. Bu gibi durumlarda rotasyona izin veren menteşeli diz protezleri problemlerin çözümünde değerli olabilir. Bu çalışmada rotasyona izin veren menteşeli diz protezlerinin orta dönem sonuçlarını değerlendirmeyi amaçladık. **Gereç ve Yöntem:** Hastanemizde Şubat 2009 – Aralık 2011 yılları arasında, 18 hastanın 21 dizine ( 7 primer ve 14 revizyon) uygulanmış olan rotasyona izin veren menteşeli diz protezleri retrospektif olarak değerlendirildi. Çalışmaya 4 erkek 14 bayan hasta dahil edildi. Hastaların ortalama takip süresi 54 aydı. Hastaların yaş ortalaması 75 idi. **Bulgular:** Hastaların ameliyat öncesi Hospital for Special Surgery diz skoru ortalama 44, Diz Cemiyeti diz ve fonksiyonel skorları ise sırasıyla ortalama 27, 18 iken ameliyat sonrası son takiplerinde skorlar sırası ile 83, 82, 70 olarak tespit edildi . Ayrıca ameliyat öncesi ortalama 76 derece olan diz eklemler hareket açıklığı ameliyat sonrası son takiplerinde 101 dereceye artış gösterdi. İki hastada ameliyat sırasında patellar tendon rüptürü gelişirken dört hastada (%19) ameliyat sonrası dönemde periprotetik kırık, aseptik gevşeme, periprotetik enfeksiyon ve patellofemoral instabilite gibi çeşitli komplikasyonlar gelişti. En kısa takip süremiz olan üç yıl sonunda protez sağkalımı %90 olarak tespit edildi. **Tartışma:** İleri bağ instabilitesi yada ciddi kemik kaybı varlığında, rotasyona izin veren menteşeli diz protezleri, primer veya revizyon diz artroplastisinde başarı ile uygulanabilir. Bununla beraber yüksek komplikasyon oranları her zaman akılda tutulmalıdır.

#### Anahtar Kelimeler

Rotasyonel Menteşeli Diz Protezi; Ligament Laksitesi; Kemik Defekti; Revizyon Diz Protezi;

#### Abstract

**Aim:** In surgeries on patients with advanced ligament instabilities or severe bone defects rotating hinged knee prostheses are one of a limited number of appropriate options. The objective of our study is to evaluate the mid-term functional results and complications of several surgeries using this form of prosthesis. **Material and Method:** The rotating hinged knee prosthesis (RHKP) was applied to 23 knees of 19 patients in primary or revision surgeries at our institution between February 2009 and December 2011. Following their operations, patients underwent several retrospective evaluations to assess surgical success. The average follow-up period for the patients was 54 months. The average age of the patients at their last follow-up was 75. **Results:** The average Special Surgery Knee Scores, Knee Society Knee Scores, and Knee Society Functional Scores were 44, 27, and 18, respectively, before the surgery; and 83, 92, and 70 in the final post-surgery follow-ups. In addition, the average range of motion increased from the pre-operative level of 76 to 101 degrees at the final evaluation. Two patients had pre-operative rupture of the patellar tendon, and four patients had various complications after the surgery, including periprotetic fracture, deep infection, aseptic loosening, and patellofemoral instability. **Discussion:** Primary or revision knee arthroplasty using RKHP can be successful in cases with advanced ligament instability or severe bone defects; however, increased complication rates should be kept in mind.

#### Keywords

Rotating Hinge Knee Prostheses; Ligament Laxity; Bone Defect; Revision Knee Arthroplasty

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## Introduction

Primary knee arthroplasty is frequently used in orthopaedic surgery, especially for degenerative and inflammatory arthropathies. Given the high success rate for this surgery, it has been increasingly indicated, with a corresponding rise in the number of applications [1]. It is estimated that primary knee arthroplasty and total knee revisions will increase by 674% and 601%, respectively, in the United States between 2005 and 2030 [2]. For the vast majority of revision knee surgeries, minimally constrained knee prosthesis designs are successfully used. However, more constrained designs such as rotating hinged knee prosthesis (RHKP) may be required in revision cases with advanced bone defects or ligament instability [3]. Similarly, more restrictive designs may be preferred in primary knee arthroplasty in case of advanced bone defect or global ligament instability [4,5].

The first generation of hinged knee prosthesis designs employed a simple mechanism permitting only flexion and extension. Since these designs did not allow either rotation or varus-valgus, stress forces were transmitted directly to the bone-cement interface, leading to rapid loosening and high failure ratios [4,6]. Recently, these unsuccessful results have inspired a number of innovations including increased rotational ranges, augmentation with metal blocks and wedges to fill bone gaps, and modular stem options to improve alignment and press-fit fixation [7-11]. Furthermore, patellofemoral complications, which were frequently reported in the past, have largely been addressed by deepening the patellofemoral groove and increasing joint congruency [12].

In this study, we evaluated mid-term functional results and complications that occurred during the period following the insertion of RKHP in patients who had severe bone defects or advanced ligament instability.

## Material and Method

RHKP were used in 21 knees of 18 patients whose clinical data were retrospectively evaluated at our institution between February 2009 and December 2011 following approval from the local ethical research committee.

Fourteen of the patients were female and 4 were male. RHKP were used in 14 knee revision surgeries (13 patients) and in 7 primary knee arthroplasties (5 patients). In the case of the revision surgeries, indications were ligament instability in 9 patients and bone defects in 4 patients (Figure 1); in the case of the primary surgeries, indications were severe varus-valgus deformity with ligament instability in 3 patients and ligament instability with previous trauma history in the remainder (Figure 2). The average age of the patients was 75, and the range was from 60 to 92. The average follow-up time was 54 months, but this varied between 38 and 74 months (Table 1).

All surgeries were performed under normotensive epidural anesthesia. Prophylactic first-generation cephalosporin antibiotics were used from presurgery until 24 hours post-surgery. Surgeries were performed under tourniquet control and the medial parapatellar arthrotomy approach was used. In one case, a rectus snip and, in another case, a tibial tubercle osteotomy were required due to inadequate exposure. The RHKP used in each case was the RT Plus model produced by Smith & Nephew. A



Figure 1. A 74-year-old female patient with varus gonarthrosis and no prior treatment. The photos show the patient's pre- and post-operative (60 months) conditions.



Figure 2. This 76-year-old female patient had a total knee arthroplasty three years prior to the revision surgery we performed. The patient presented with an advanced ligament instability which was resolved with an Rotating hinged knee prosthesis.

patellar replacement was used only in the case of one patient who had previously had such a replacement. Long cementless press-fit stems were used in all but one case in which a tibial stem was used instead. In the metaphyseal region cement was used. Low molecular weight was used for DVT prophylaxis during the month following each surgery.

Table 1. Patient Information

Patient demographics	
No of patients	18
Female/male	14/4
Indication for surgery	
Primary	7
Ligament instability	7
Bone deficiency	-
Revision	14
Ligament instability	10
Bone deficiency	4
Age	75 (60-92)
Follow-up	54 months (38-74)

Quadriceps exercises began 2 days after surgery except in the case of one patient who had a tibial tubercle osteotomy and 2 patients who had intraoperative patellar tendon ruptures. Patients with extensor mechanism problems used braces for 6 weeks, and were mobilized by limiting weight bearing. Other patients were allowed to move with walkers and were allowed full weight bearing.

The knee flexion and extension angles of patients were measured before and after the surgeries. Flexion contracture, extension lag, instability, and lower extremity alignment were also evaluated, as were the presurgery and post-surgery pain and functional situation of the patients. Using these data, Knee Society scores (KSS) and Hospital for Special Surgery (HSS) knee scores were calculated. At the final follow-up, alignment and osteolysis findings were evaluated with AP LAT plain graphics and orthoroentgenography.

All data gathered in this study were analyzed using IBM Statistics SPSS v20 (SPSS Inc. IBM, Chicago, USA) software. Wilcoxon and Mann-Whitney U tests were performed, and a p-value less than 0.05 was considered statistically significant.

## Results

All but 2 of the patients experienced improved knee functional scores following their surgeries.

The average preoperative KSS and functional scores of the 18 patients (21 knees) were 27.3 and 17.6, respectively. At the end of the follow-up period, these values were recorded as 81.7 and 70, respectively. Additionally, the average HSS score increased from 43.8 (preoperatively) to 83.3. These improvements were statistically significant ( $p < 0.001$ ) (Table 2). The patients' average range of motion increased from 76.2 to 101.2 degrees ( $p < 0.001$ ).

Sixteen of the 18 patients reported a decrease in their knee pain. These patients were pleased with their functional improvement. Two patients were not pleased with their results and exhibited no improvement in functional scores.

At the final follow-up, 10 patients were able to walk without any support, 3 patients needed a walking stick, 3 patients needed double walking sticks, and 2 patients needed walkers.

In radiologic examination there were non-progressive asymptomatic radiolucencies less than 2 mm in 16 (76.2 %) of the knees. Altogether, 13 (61.9 %) tibial components and 8 (38.1 %) femoral components were affected.

Intraoperative complication rates were 9.5 % and postopera-

Table 2. Pre-surgery and post-surgery metrics and their statistical significance

Clinical and functional results	
Knee Society score	
Pre-op	27.3 ± 12.3 (13-65)
Final	81.7 ± 21.3 (13-100)
P value (pre-op versus final)	<0.001
Functional score	
Pre-op	17.6 ± 14.4 (0-40)
Final	70.0 ± 27.1 (0-100)
P value (pre-op versus final)	<0.001
HSS Knee score	
Pre-op	43.8 ± 6.2 (33-61)
Final	83.3 ± 18.3 (20-98)
P value (pre-op versus final)	<0.001
ROM	
Pre-op	76.2 ± 23.1 (35-110)
Final	101.2 ± 11.5 (90-125)
P value (pre-op versus final)	<0.001

tive rates were 19%. Intraoperative patellar tendon rupture occurred in 2 patients; in both cases this was addressed by using primary repair with anchor sutures. At the final follow-up, both patients had active extension and no extensor problems were detected. One patient had an asymptomatic patellar dislocation at angles above 90 degrees knee flexion. Due to this patient's additional medical concerns, a conservative treatment was pursued. One patient experienced a tibial component periprosthetic fracture a year after the surgery. To minimize surgical invasion, this was addressed through an open-reduction internal fixation; however, this failed within a short time. In this case, a RKHP with a longer tibial stem was used for the revision. Another patient experienced painful aseptic loosening of the femoral component at her sixth month. The patient visited a different health center regarding the issue and a femoral component revision was performed; however, this had not resolved the patient's symptoms by the time of the final follow-up. An early-stage acute hematogen deep periprosthetic infection was detected in another patient at the 54th month of follow-up and treated with debridement and by an insert replacement surgery accompanied by intravenous antibiotherapy. Following this surgery, the clinical and laboratory findings of the patient became normal in the second month (Table 3).

The prosthesis survival was 90% at the end of 3 years, which

Table 3. Complications and Treatments

Complication	Occurrence Time (months)	Treatment	Comment
Patellar tendon rupture (2)	Intra-op	Primary repair	Intact extensor mechanism
Aseptic loosening (Femoral component)	6	Revision with rotating hinge knee	Pain exists
Periprosthetic fracture (Tibial component)	12	Revision with long tibial stem	Patient is mobile with weight bearing
Patellofemoral instability	Post-op	Conservative	Observation
Deep infection	54	Debridman + I.V antibiotherapy	Clinical and laboratory, no infection

was the duration of the shortest follow-up period in our study.

## Discussion

The number of primary and revision knee surgeries is rising due to aging populations and increasingly successful arthroplasty results. Severe bone defects and global ligament instability are examples of the problems that surgeons can encounter in knee arthroplasty. Modern rotating hinged knee prostheses may be helpful in solving these problems.

A vast amount of research has been conducted on RHKP indications, clinical and functional results, and complications encountered. It is quite difficult to compare these studies as each has different patient selection methods and uses different implant types.

Bistolfi et al. stated that RHKP used as the primary treatment presents evidence for statistically significant improvement. However, since RHKP have higher complication rates compared with other designs, they are suggested only for patients who have severe bone defects or ligament instabilities [13]. Petrou et al. applied RHKP on 100 knees (80 patients) and tracked them for 11 years on average. They found that 91% of prostheses ranked as good-excellent in terms of results and 95% of prosthesis remained undamaged, indicating a success rate close to the standard knee prosthesis. They also indicated that these designs may be an effective solution for patients with severe bone defects or ligament instabilities [14].

The main problem in revision surgery is managing ligament instability since this affects both the functional results and prosthesis survival [15,16]. Even though there are various component design and constraint levels, it is still quite difficult to select the ideal design for particular patients in some cases. Selection of the appropriate prosthesis design will depend on ligament stability and bone loss severity [17, 18]. If ligaments are strong and there are no serious bone defects, posterior substitution designs are preferable, whereas when there are ligament instability and mild to severe bone defects, hinged knee designs should be used [15, 19]. Non-hinged condylar restrictive designs are appropriate alternatives for cases of mild ligament instability [20, 21].

For example, Hossain et al. examined the results of 349 revision surgeries for a minimum of 12 months and used 3 different designs. They used posterior cruciate substituting knee prostheses for cases with contact and functional ligaments, condylar revision knee prostheses for cases with mild ligament instability, and RHKP for cases with severed collateral ligaments. Among these groups, RHKP exhibited both the highest rate of satisfaction (88%) and the highest rate of prosthesis survival (90.6%). The authors concluded that although constrained designs are not generally appropriate, their use in the aforementioned situations can lead to long-term success and improved knee stability [22].

In our study, the prosthesis survival rate was 90% at the end of 3 years, which was our shortest follow-up period. Our results are in line with the literature in terms of increased post-surgery clinical improvement, functionality conditions, increased range of motion, and survivorship. Despite these successful results, less-constrained designs remain the preferred choice except in instances of global instability or severe bone defects.

In the literature, there are discussions on stem usage and length, which inform fixation and alignment [23, 24]. Jazrawi et al. examined the knees of 12 cadavers and found that as stem diameter and length increased, there was a corresponding decrease in movement at the tibial tray [25]. Randay and Schuderi suggested that stem length should be selected based on the quality of the bone stock and canal diameter. Short stems or cemented narrow stems are preferable if the bone quality is high, while long press-fit stem techniques are preferable if the bone quality is low [18]. Parsley and Sugano showed that using long canal-filling cementless stems in revision surgeries reliably improves alignment [26]. Haas et al. stated that 84% of patients who had revision surgery because of aseptic loosening experienced excellent mid-term results with long stems [23]. During the follow-up, they found non-progressive asymptomatic radiolucent lines along 64% of tibial stems and 33% of femoral stems. Based on our results, we agree that long stems would improve alignment and fixation. For this reason, in all cases except one tibial component, we preferred long stems both for femoral and tibial components. One patient had aseptic loosening of the femoral component and another patient had a periprosthetic fracture along the tibial stem. At the final follow-up we found non-progressive radiolucent lines along 13 (61.9%) of tibial components and 8 (38.1%) of femoral components. We were unable to find a relationship between these lines and the clinical results.

It is known that RHKP have higher complication ratios than less-constrained designs. These can be, at least in part, attributed to challenging patient indications and morbidities [27]. Guenoun et al. applied RKHP on 85 patients, whose average age was 72.4. Out of 85 patients, 52 had primary arthroplasty and 33 had revision arthroplasty. In their study, they tracked the patients for an average of 36 months, and detected complications in 24 patients (28.2%). The frequent complications were deep infection (9 patients), patellar complication (4 patients), and aseptic loosening (3 patients). There was no statistically significant difference between primary and revision surgeries in terms of complication ratios. Nevertheless, there was a significant relationship between complication ratios and morbidities such as diabetes, obesity, and heart diseases [27]. Springer et al. (2001) followed 69 RHKP surgeries (primary or revision) on 58 patients for an average of 75.2 months and found at least one complication in 23 knees (32%). The most frequent complications were deep infection (14.5%), patellar complication (13%), and periprosthetic fracture (10%). They stated that RHKP designs should be considered as the last option for complex primary knee arthroplasty or revision surgeries [9]. Pour et al. tracked 44 RHKP cases for an average of 4.2 years and detected periprosthetic infections in 3 patients, aseptic loosening in 4 patients, and a periprosthetic fracture in one patient [3]. In our study, we found aseptic loosening of the femoral component in one patient, a periprosthetic fracture of the tibial component in one patient, a deep infection in one patient, and patellofemoral complications in another, totaling 4 major complications (19%).

## Conclusion

Rotating hinged knee prostheses are helpful in situations where



applying minimally restricting knee prostheses is not possible, such as those cases involving severe bone defects, ligament instabilities, or severe deformities. While the long-term results of our study are not yet known, the mid-term results show decreased patient pain and improved clinical and functional situations. Despite these positive results, one should bear in mind the high complication rate during the treatment period.

### Competing interests

The authors declare that they have no competing interests.

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